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Snow sampling studies in the
vicinity of Kidd Creek Mines
Limited, Timmins.

1983.

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SNOW SAMPLING STUDIES IN THE VICINITY OF
KIDD CREEK MINES LIMITED
TIMMINS
1983

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Snow Sampling Studies at Kidd Creek Mines 1983

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I INTRODUCTION

In 1972, Kidd Creek Mines Limited began operation of an electrolytic zinc smelter complex at Hoyle, Ontario. Following the start-up of the operation, the Ministry of the Environment conducted surveys which demonstrated that the concentrations of several metallic elements were increasing in vegetation and soil in close proximity to the smelter. Also it was found that a similar situation was developing along the Ontario Northland Railway, particularly in proximity to a railroad siding immediately east of the refinery. Ore concentrate was allowed to remain in uncovered rail cars on the siding for various periods of time. It was possible for wind to blow the surface layers of the concentrate from the rail cars. This was shown to occur in studies which involved collection and analysis of snow samples collected in the vicinity of the railroad siding. Elevated concentrations of zinc, copper, lead, and sulphate were elevated in close proximity to the tracks and decreased with distance from the railway (MOE, unpublished data).

Kidd Creek Mines has implemented various measures to reduce concentrate emissions from the rail cars. Different materials were applied to the surface of the concentrate in an effort to create a surface seal to reduce loss of the concentrate by wind action. A follow-up investigation was undertaken in 1983 to assess the effectiveness of the various measures which have been taken at the request of the Timmins District Office. Since the railroad siding area in question also falls within the zone of influence of emissions from the smelter complex itself, it was necessary to consider how the area might be impacted by both the railroad and the smelter complex. This report presents the data from a snow sampling study conducted during the winter of 1983 as well as data from comparable studies completed in 1975 and 1976.

II METHODS

(i) Kidd Creek Study

Five locations were sampled for snow in the vicinity of the Kidd Creek Refinery Complex. The stations were selected to correspond with snow sampling locations of previous years and in some cases with established soil and vegetation sampling stations. The stations indicated in Figure 1 are located as follows in relation to the zinc remelt furnace stack.

<u>Station Number</u>	<u>Approximate Location</u>
4	8 km northeast
13	1 km northeast
26	1.6 km east northeast
44	0.8 km northeast
53	0.1 km south

Snow sample collections were made on February 22, 1983.

(ii) Railroad Study

Snow samples were collected at 3 locations along Ontario Northland Railway. The locations of these stations are shown in Figure 2. These sites were selected to correspond with sampling locations of previous years. Samples at Sites 38 and 39 were taken at 1 meter, 50 meters, and 100 meters in both north and south directions from the track. At Site 41, samples were taken 1 meter, 50 meters, and 100 meters only in an easterly direction from the track.

(ii) Sample Collection

At each sample location, duplicate samples of snow were collected. The sample consisted of circular cores of snow, 12 cm in diameter and represented a complete profile of snow from the surface to the ground level. The sample was taken in such a manner as to avoid contamination by ground materials. The number of cores required to fill 4.5 kg polyethylene bags was recorded. The samples were returned to the laboratory and allowed to melt over night at room temperature in the polyethylene bags. The volume of snow meltwater was measured and a pH measurement taken immediately. Each sample was then divided into two equal portions and one of these portions were preserved by addition of 2 ml of nitric acid. The acidified portion was analyzed for copper, zinc, lead, nickel and cadmium while the SO_4 , sodium, and chloride concentrations were determined from the non-acidified portion.

At the time of the sampling, the total depth of snow was recorded as well as depth of fresh snow and the number of crust layers. Notes were made on the number and type of any banding or layering in the snow profile.

III RESULTS

(i) Kidd Creek Study

The condition and depth observations as well as snowmelt water pH measurements made on the snow samples collected in the vicinity of the Kidd Creek operation are presented in Table 1. Snow depth ranged from 52 to 62 cm. Faint banding in the snow profile was noted only once (Station 53). The pH values differed little from site to site and ranged between 4.9 and 5.4. These values were however moderately lower than the pH values observed in the 1976 samples. A comparison of the 1976-1983 snowmelt pH are given in the Table below.

<u>Station</u>	<u>1976</u>	<u>1983</u>
26	5.2	4.9
44	5.9*	4.9
53	6.7	5.4

* Value is from a March sampling, all other values are from February.

The mean concentrations of elements reported in the 1983 and comparable 1976 snow samples are presented in Tables 4 to 6. The concentrations of

sulphate, zinc, copper, and lead were highest at Site 53 which is the closest site to the zinc plant. The concentrations of these elements decreased with distance from the zinc plant. In comparing the chemical concentrations at Sites 26, 53 and 44 (Table 2) for 1976 and 1983 it is evident that most element concentrations were considerably less in 1983 or are similar to the 1976 value. Copper values are moderately higher in 1983 at Sites 26 and 44 with the largest difference occurring at Site 44 where the copper concentration was .04 mg/L in 1976 and .56 mg/L in 1983. Also at Site 26, there is a noticeable increase in SO_4 content. This increase could be related to the commencement of operation of the copper refinery in 1981, however, no definite conclusions can be drawn from this limited set of samples. The metal content of the snow could also be affected by the length of the exposure to the emissions as well as the overall volume of snow. Large volumes of fresh snow could dilute the contaminant content of older snow, therefore care must be taken in making comparisons of contaminant concentrations between sampling periods.

(ii) Railroad Study

The condition and depth observations as well as snowmelt pH measurements made on the snow samples collected in the railroad study are presented in Table 3. Snow depth ranged from 27 cm to 89 cm. No banding was noted in any of the snow profiles. The snowmelt pH values ranged from 4.5 to 5.4. These pH values are moderately lower than the 1975 values as is shown in the table below.

<u>Station No.</u>	<u>1975</u>	<u>1983</u>
38, 1 meter south	5.8	4.9
38, 50 meters south	6.1	4.7
38, 100 meters south	5.9	5.1
39, 1 meter south	5.7	5.3
41, 1 meter east	5.4	5.1
41, 50 meters east	4.9	4.5
41, 50 meters east	4.9	4.6

The mean concentration of elements reported in 1983 and comparable 1975 snow samples are presented in Table 4. Concentrations of cadmium, copper, lead, and zinc, at most sites, in both years decreased with distance from the railway. These trends are illustrated for each element and site for 1983 in Figures 3 to 14. With the exception of cadmium and copper at Site 39 and lead at Site 41, the concentrations were greatest closest to the track. In comparing the 1975 and 1983 results it is evident that concentrations of most elements are substantially less in the 1983 snow samples. This is particularly noticeable for cadmium, copper, lead, and zinc concentrations while sulphate, chlorides, and sodium results for the two years were generally similar. Elevated chloride and sodium contents at Stations 38 (100 meters south) and 39 (50 meters south) are believed to be due to contamination by road salt. The degree of contamination of snow at Site 38 is greater than at Site 39. This can be attributed to the longer period during which ore cars are allowed to remain on the sidings located at Site 38. The rail traffic at Site 41 is presumably no

greater than that at Site 39, however, the concentrations of Cd and Pb elements in the snow at Site 41 are higher. It is assumed that local wind patterns at this site can cause ore concentrate to be blown from the moving railroad cars.

IV SUMMARY

A snow sampling program was conducted in the Timmins area in February 1983. The results of the study in the vicinity of Kidd Creek Zinc Smelter Operation indicated the presence of elevated concentrations of zinc, copper, lead, and sulphate in snow samples collected in close proximity to the smelter. The 1983 zinc, lead, and cadmium concentrations were substantially lower than in the 1976 samples from all three of the resampled sites. Copper concentrations were moderately higher at two sites. The pH values for 1983 were slightly lower at each site when compared with 1976.

In the 1975 railroad study, several elements (zinc, copper, and lead) were elevated in close proximity to the railway and decreased with distance from the railway. The 1983 concentrations of these metals were found to be substantially lower at most sites than in 1975.

While there are no established criteria for the quality of snow in Ontario, these results do provide a means of determining the contributions of the smelter emissions and losses of metal concentrates from railroad operations to the environment. It would appear however that emissions from the smelter complex and (at certain locations) the railroad transportation of ore concentrate are responsible for slight metal contamination of snow in proximity to the respective sources. Due to the inherent problems of the sampling of snow (namely the exposure time and the dilution of contaminant through the fall of variable volumes of fresh snow) it is not possible to make direct comparisons of concentrations of elements between separate sample collections at a given location. It is therefore not possible to interpret concentration trends with time in snow sampling surveys and therefore snow sampling surveys should not be carried out for this purpose. The only value of snow sampling is to provide a limited measure of the geographic distribution of certain contaminants at a single point in time. With these facts in mind, the interpretation of the available data suggest that the railroad is a source of some airborne metals but it is not known whether the metals are blown from the concentrate piles in the rail car, from the surface of the cars or is material re-entrained from the rail bed or some combination of these. An alternative method to snow sampling is needed to determine whether the sealing measures, which are currently being used on the rail cars, are effective.

Figure 1
Timmins Snow Sampling Program - 1983

■ -Sampling Stations

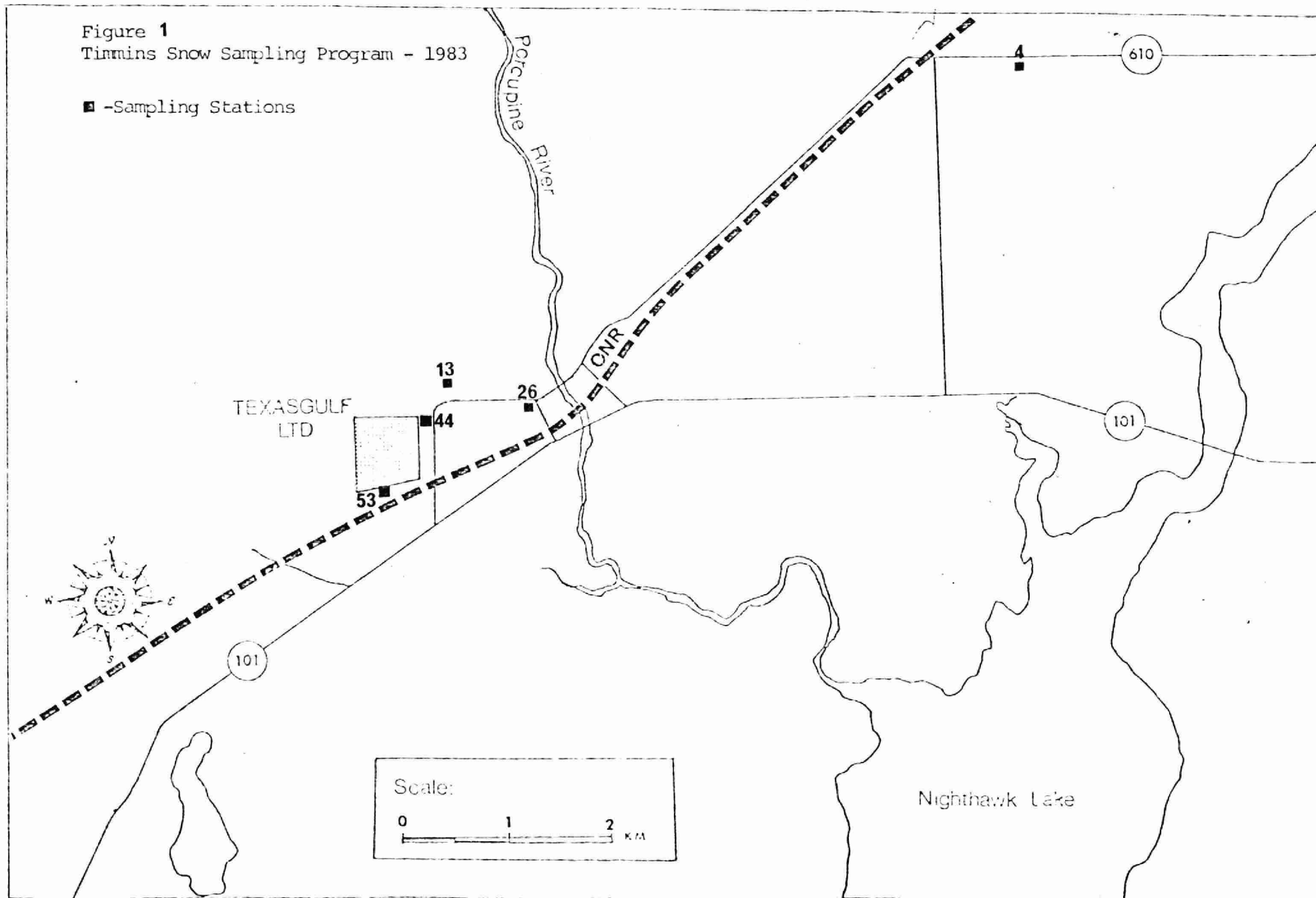


Figure 2
Tinminis Snow Sampling Program - 1983
Railroad Study

▼ Sampling Stations

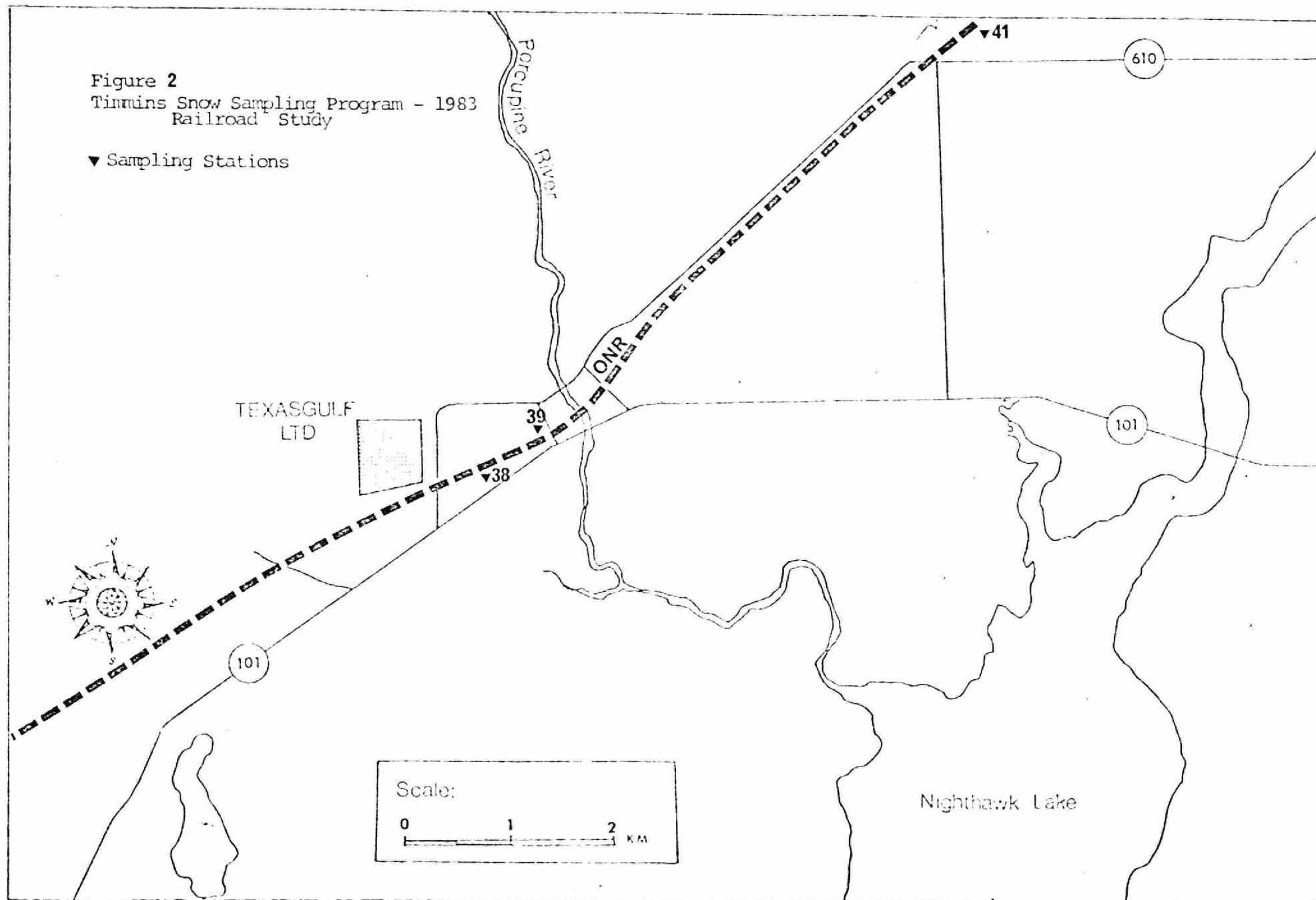


Figure 3

CADMIUM CONCENTRATION IN SNOW SAMPLES AT SITE 38

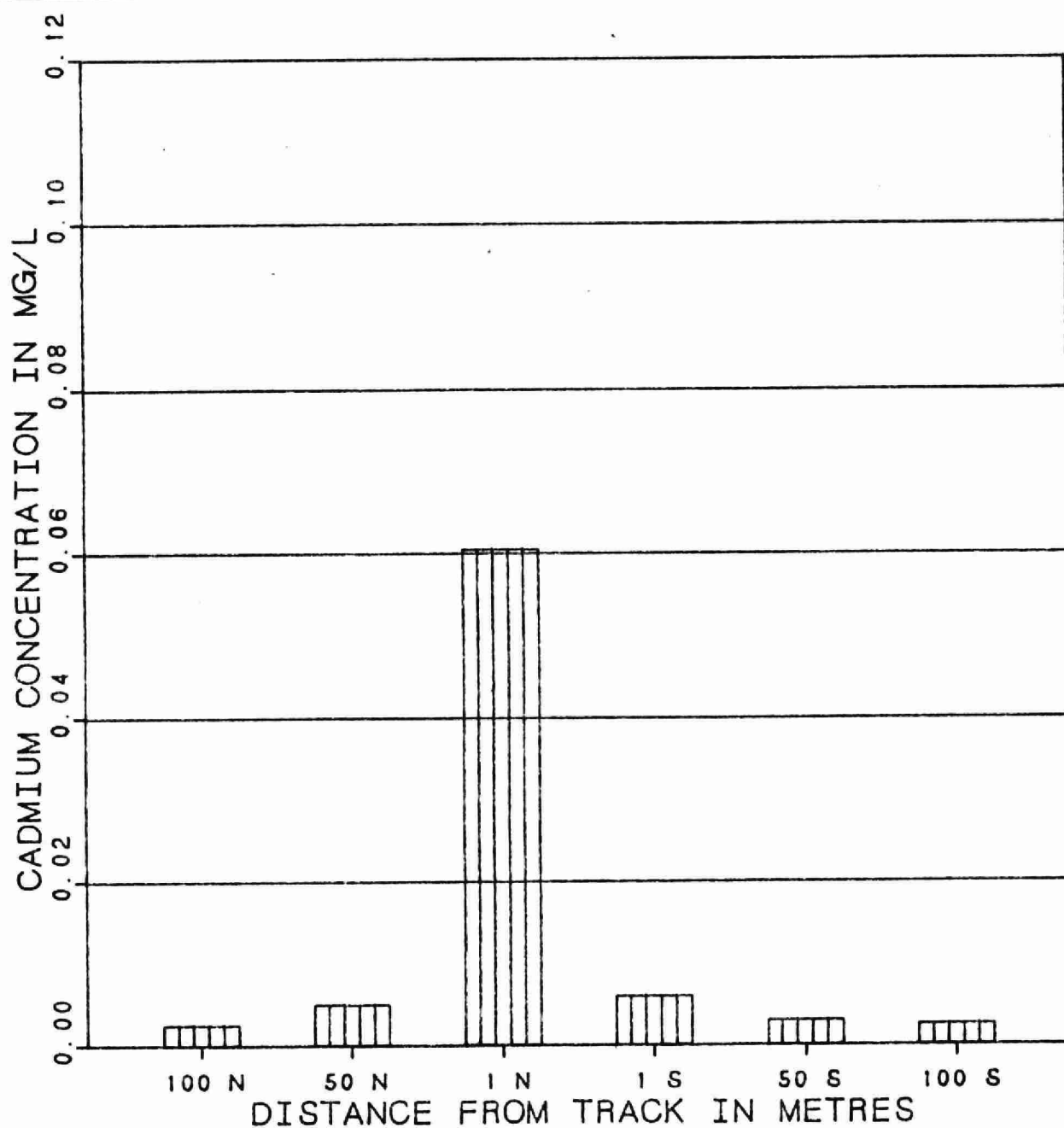


Figure 4

COPPER CONCENTRATION IN SNOW SAMPLES AT SITE 38

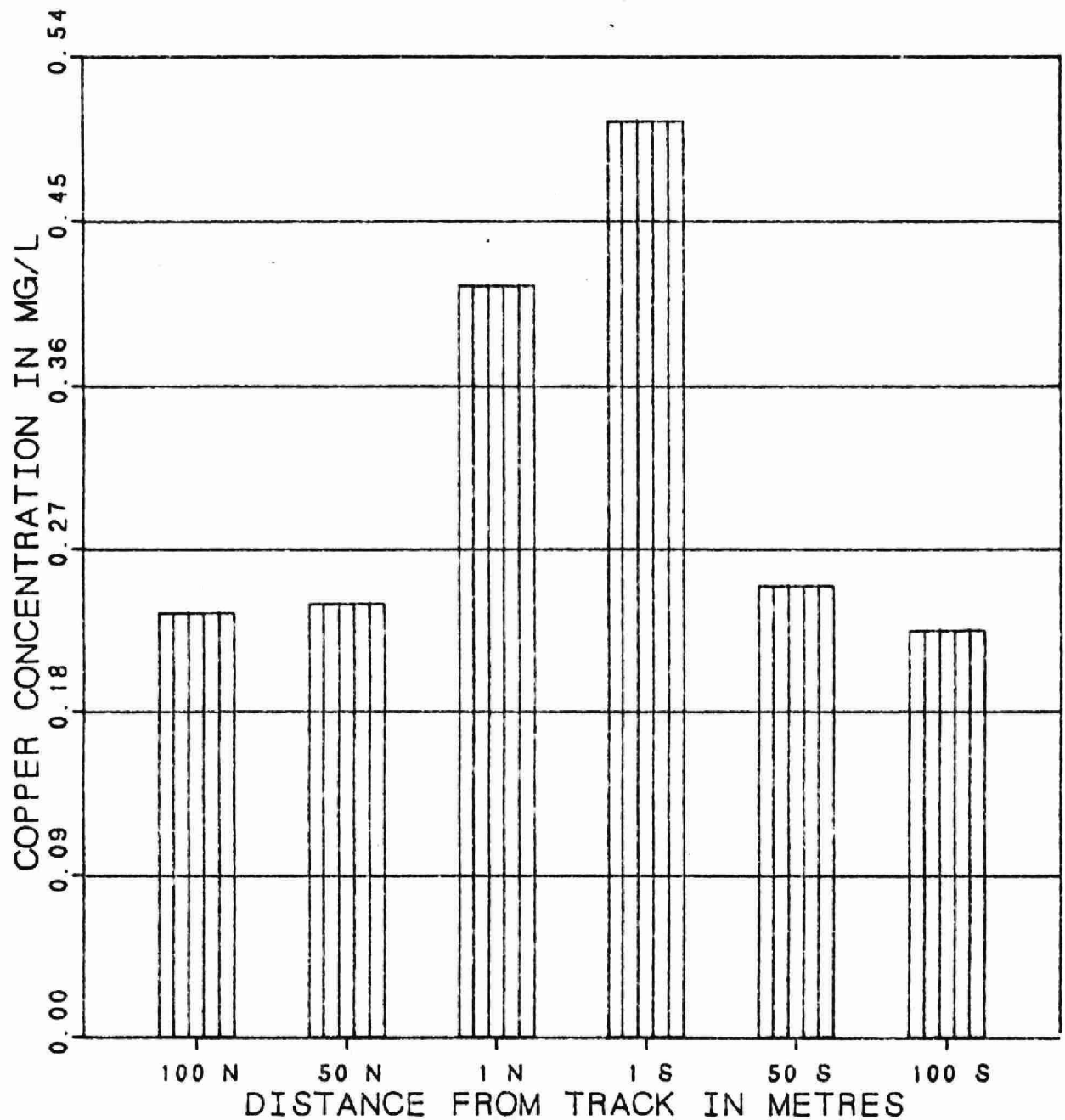


Figure 5

LEAD CONCENTRATION IN SNOW SAMPLES AT SITE 38

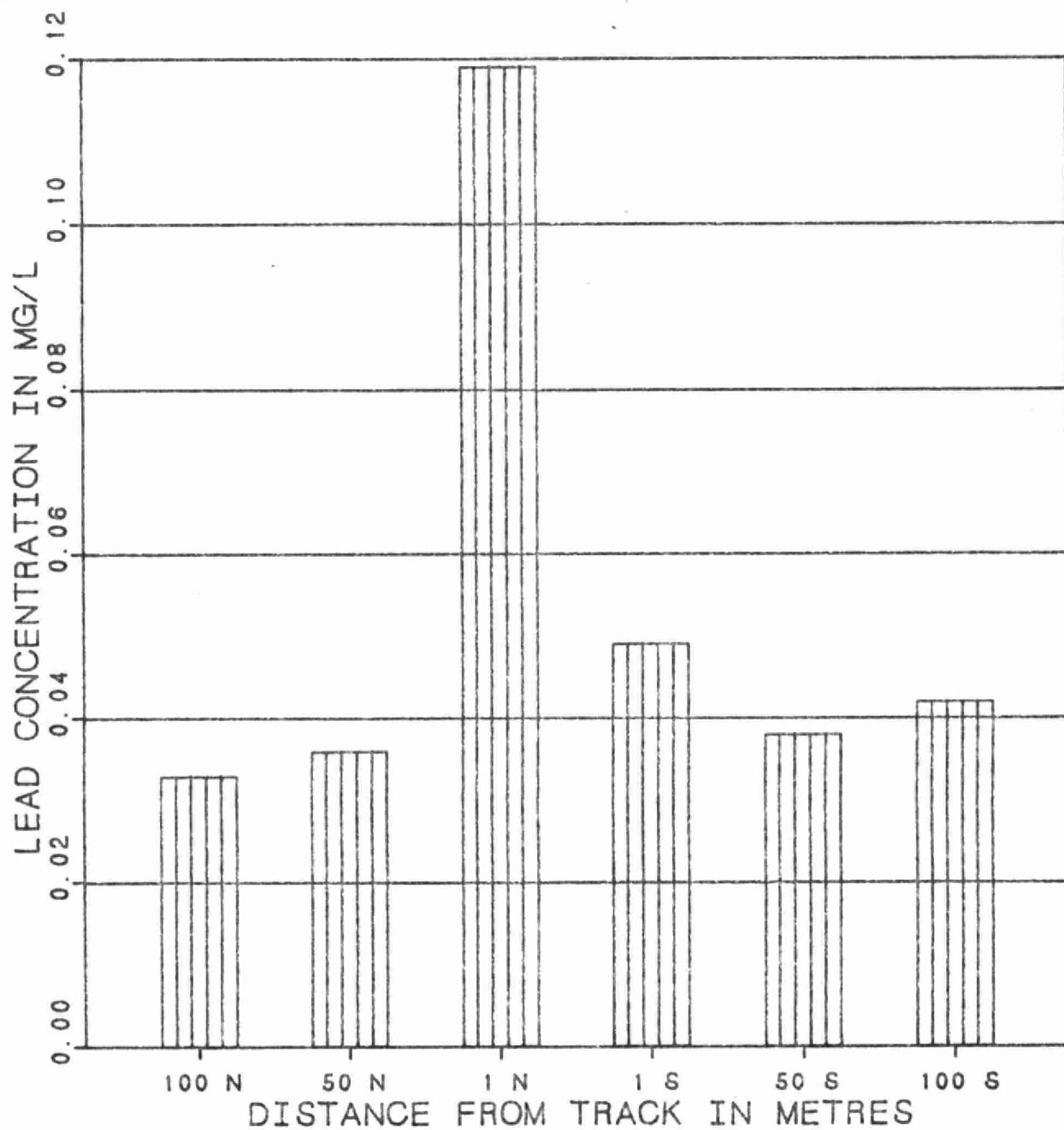


Figure 6

ZINC CONCENTRATION IN SNOW SAMPLES AT SITE 38

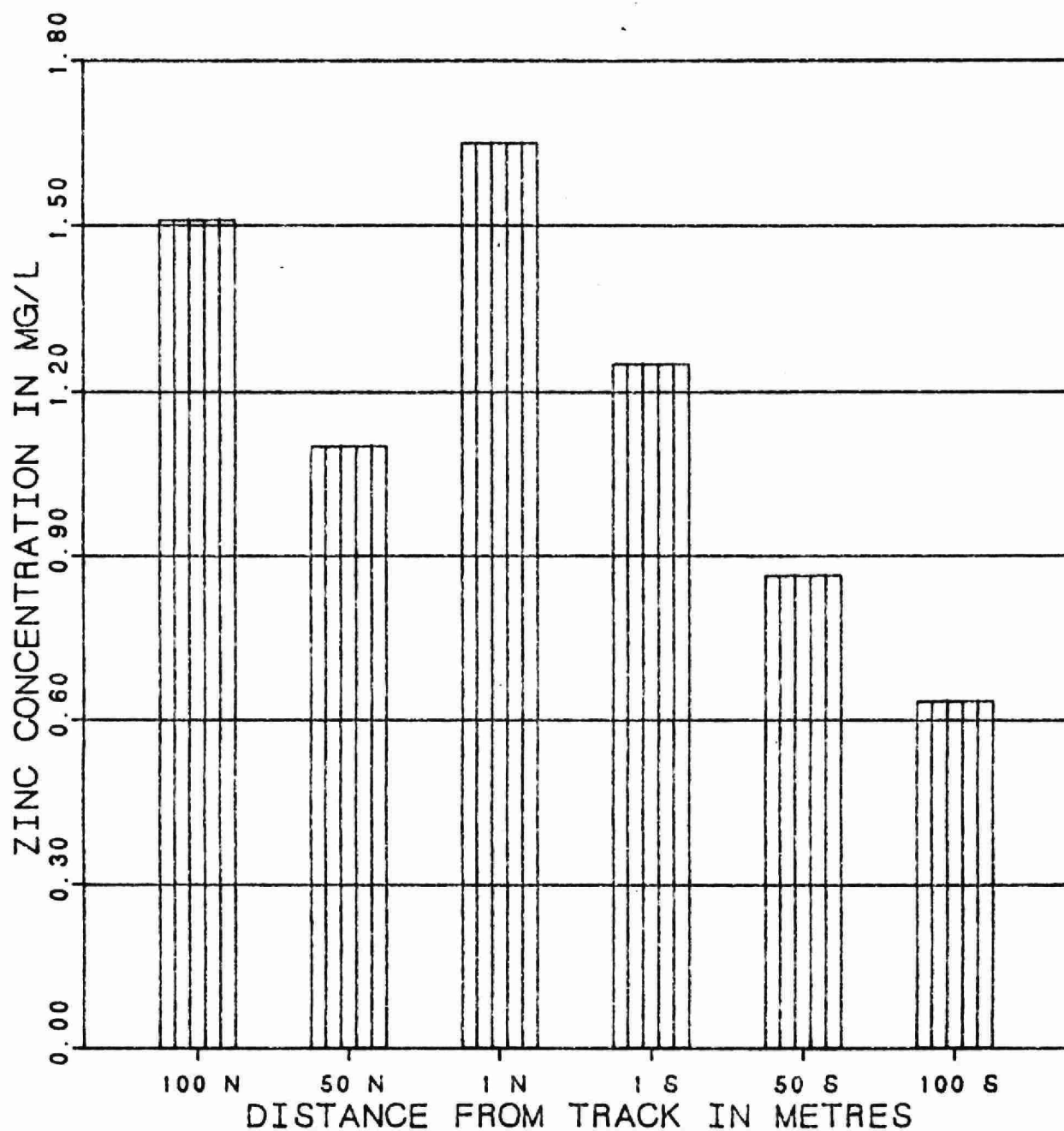


Figure 7

CADMIUM CONCENTRATION IN SNOW SAMPLES AT SITE 39

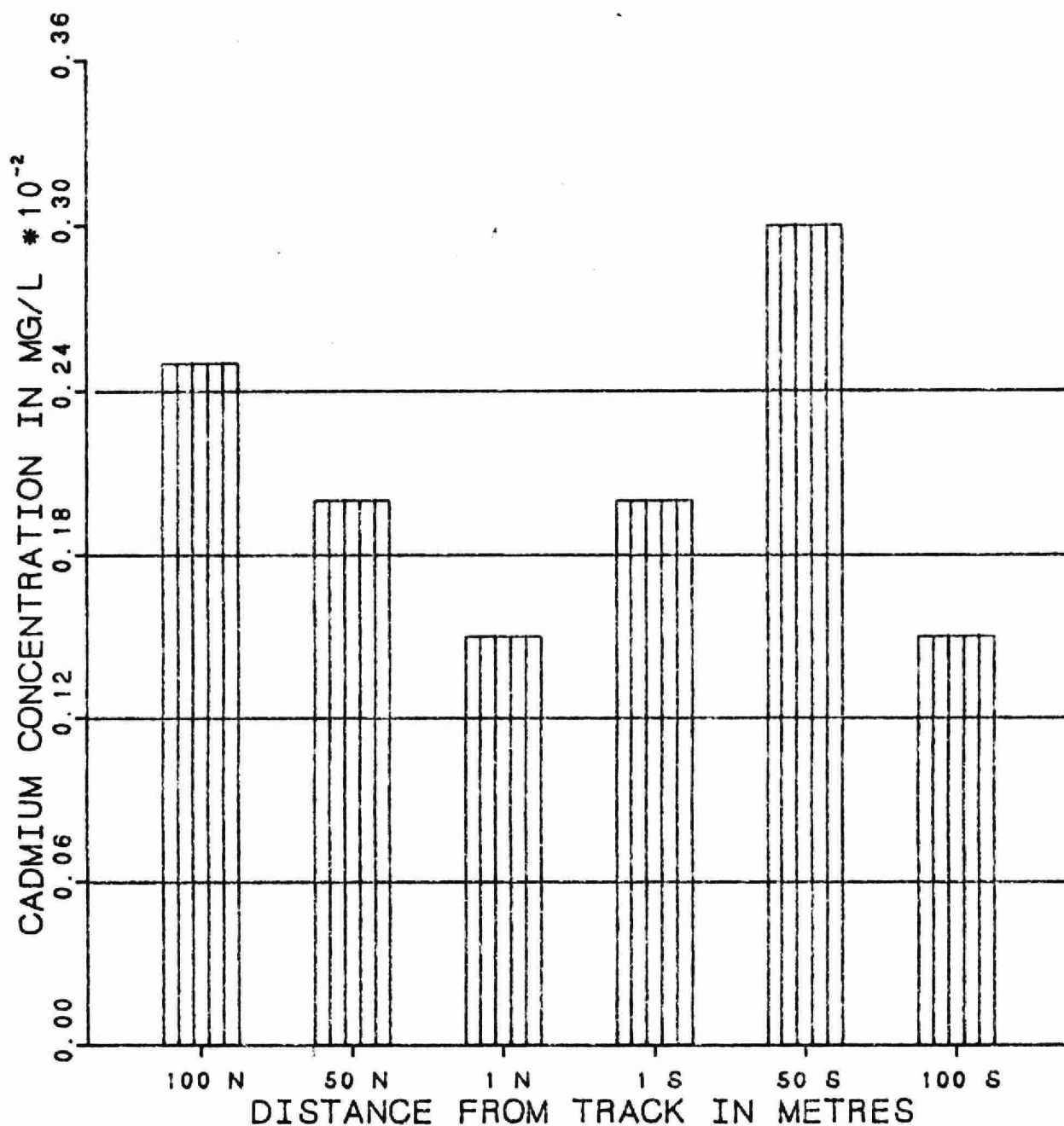


Figure 8

COPPER CONCENTRATION IN SNOW SAMPLES AT SITE 39

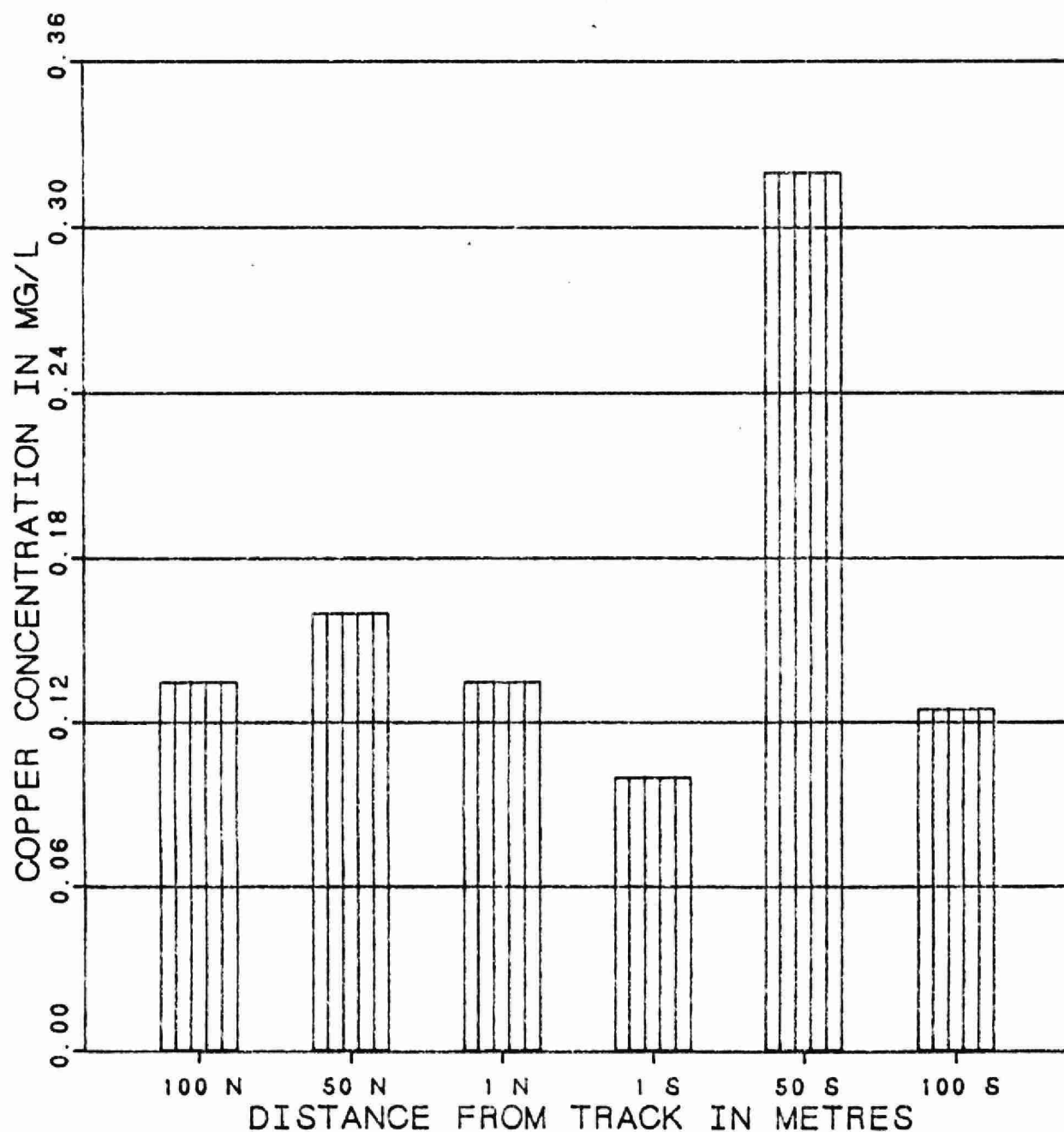


Figure 9

LEAD CONCENTRATION IN SNOW SAMPLES AT SITE 39

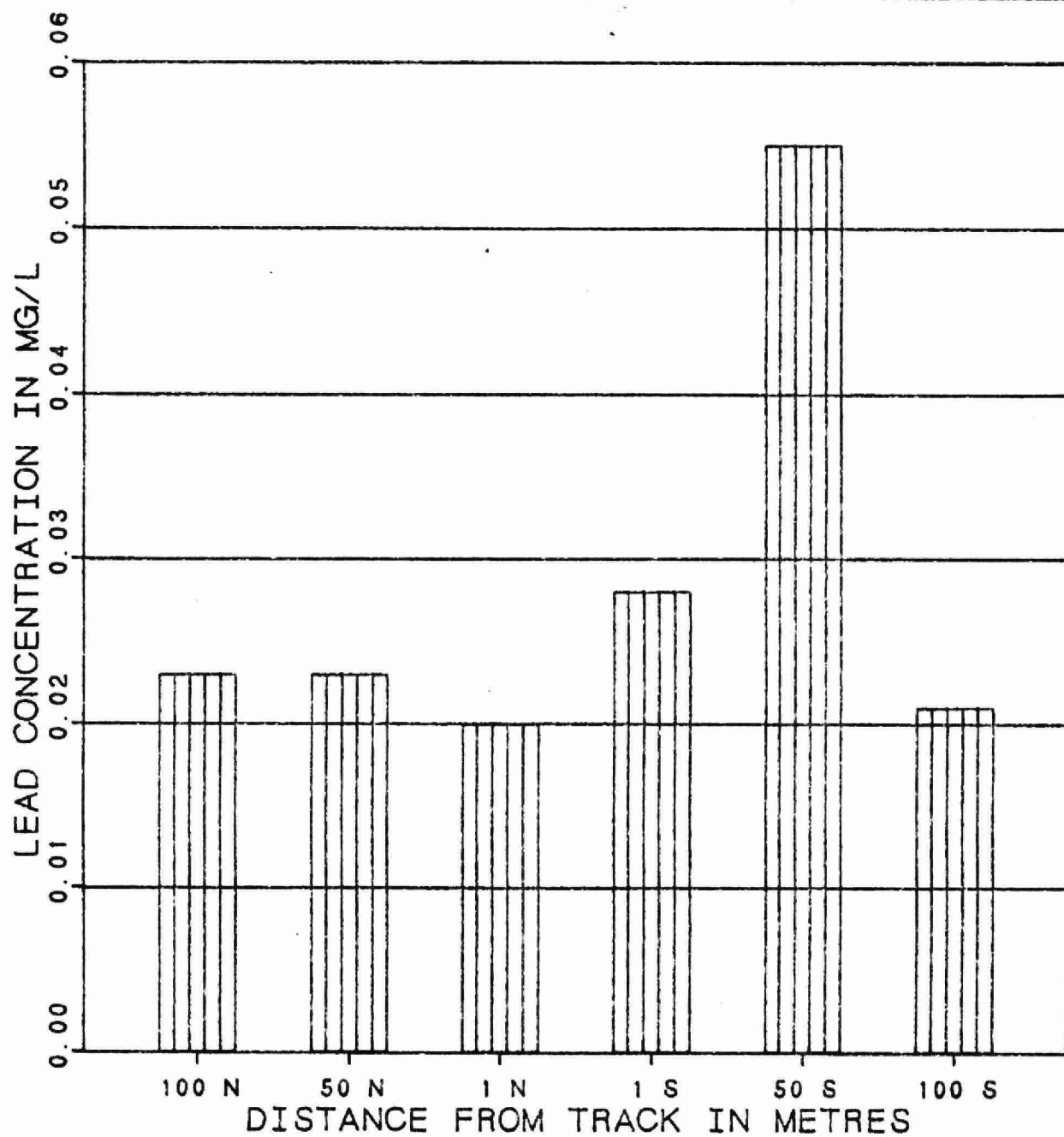


Figure 10

ZINC CONCENTRATION IN SNOW SAMPLES AT SITE 39

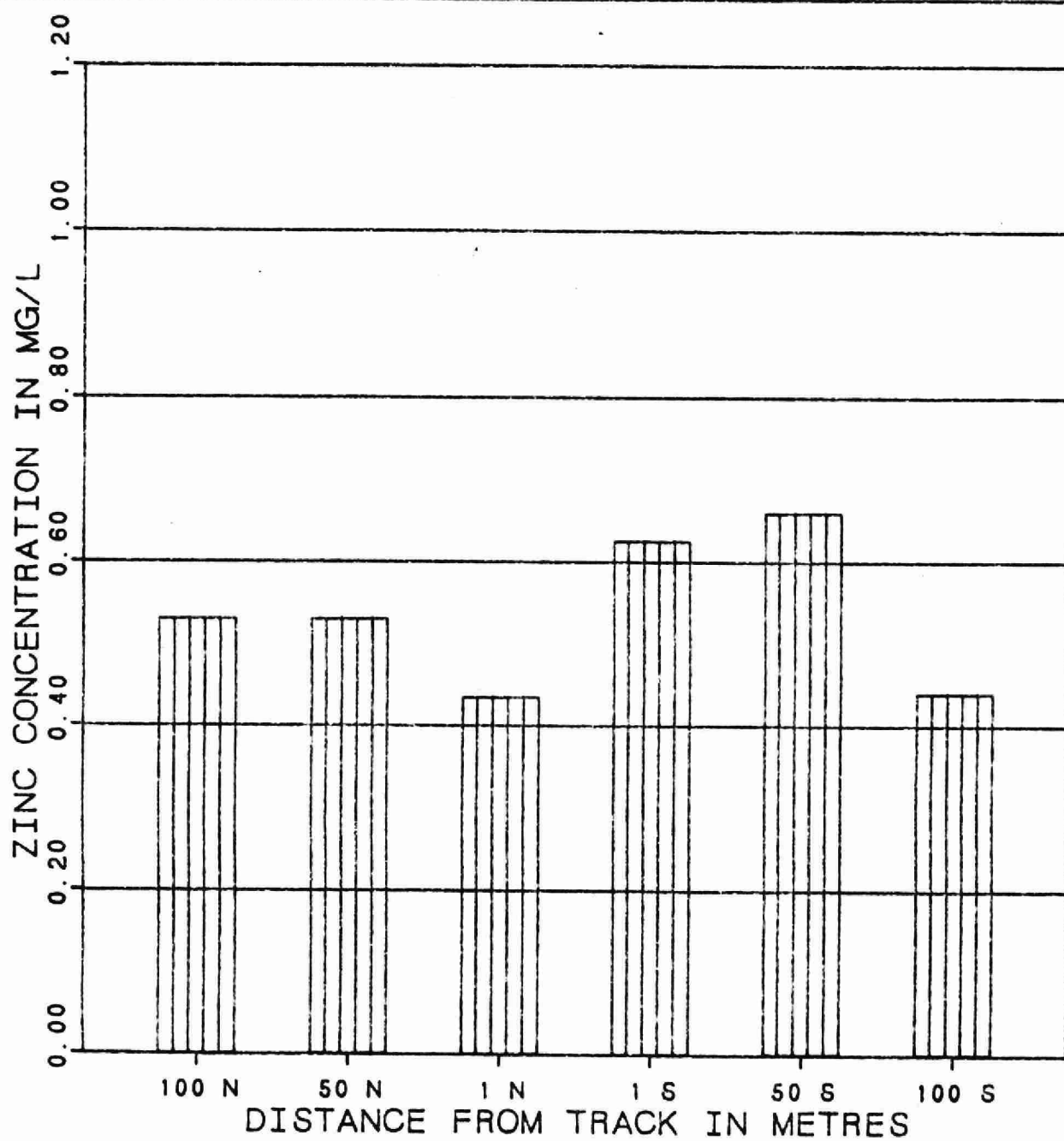


Figure 11

CADMIUM CONCENTRATION IN SNOW SAMPLES AT SITE 41

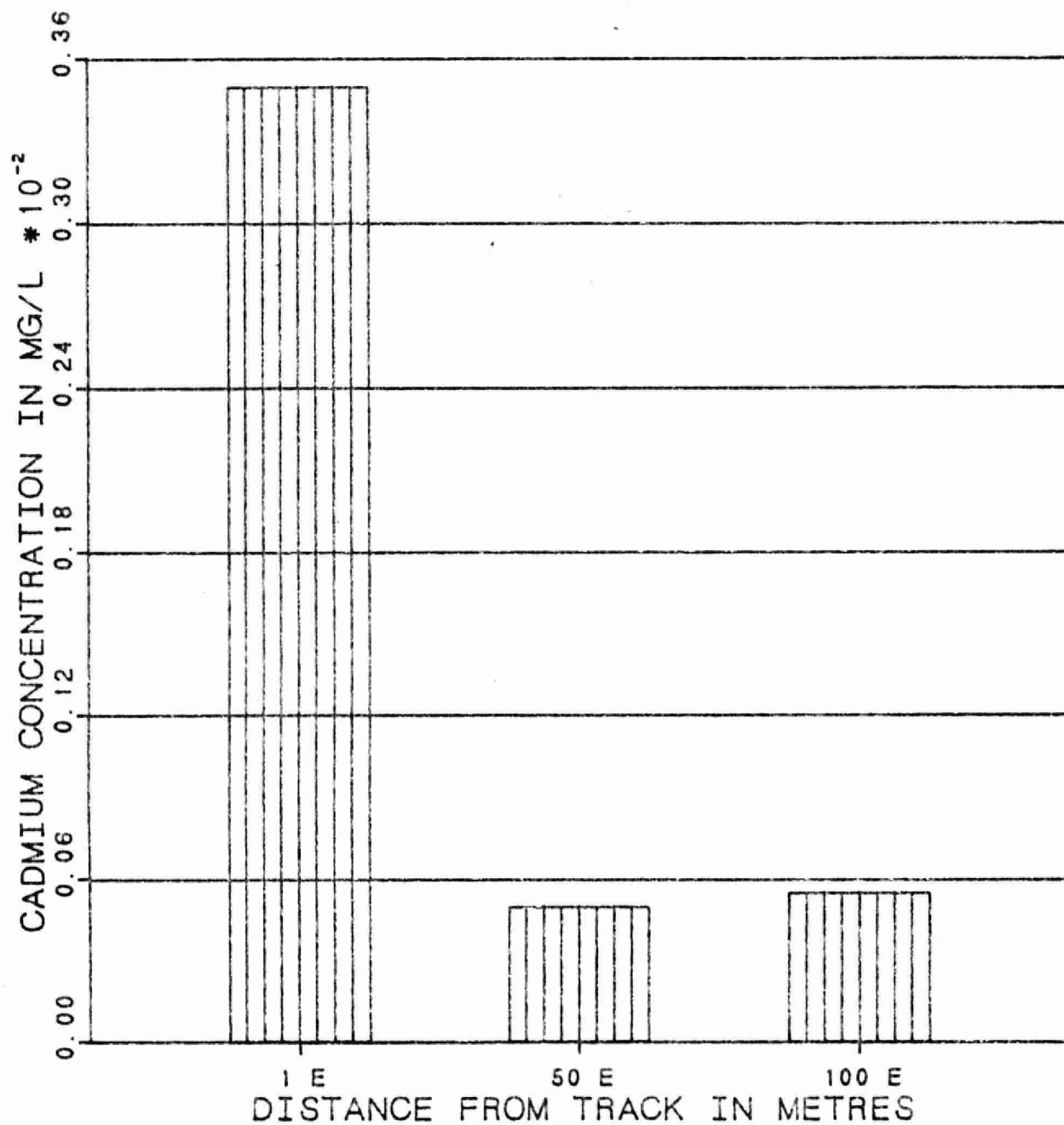


Figure 12

COPPER CONCENTRATION IN SNOW SAMPLES AT SITE 41

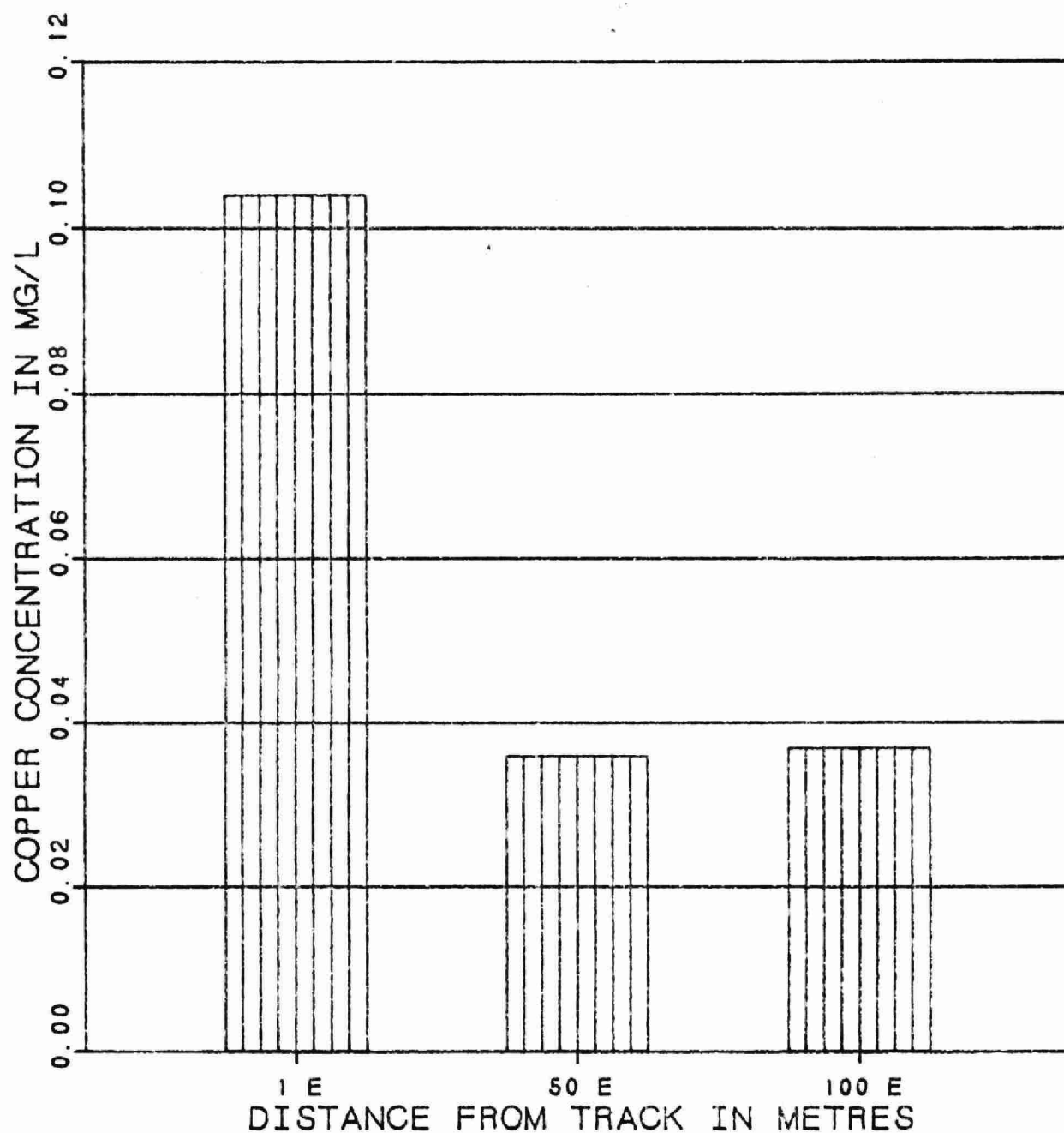


Figure 13

LEAD CONCENTRATION IN SNOW SAMPLES AT SITE 41

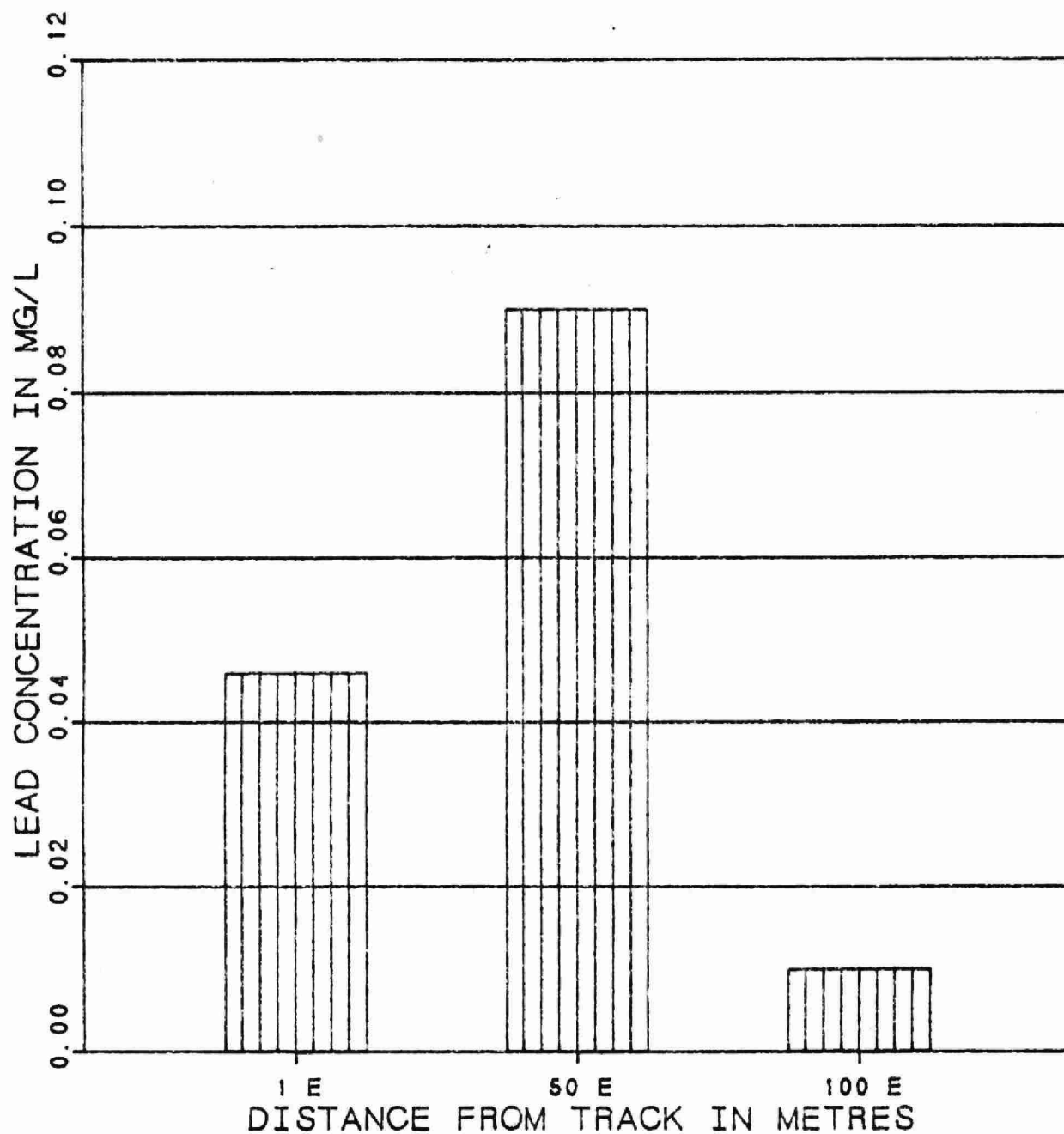


Figure 14

ZINC CONCENTRATION IN SNOW SAMPLES AT SITE 41

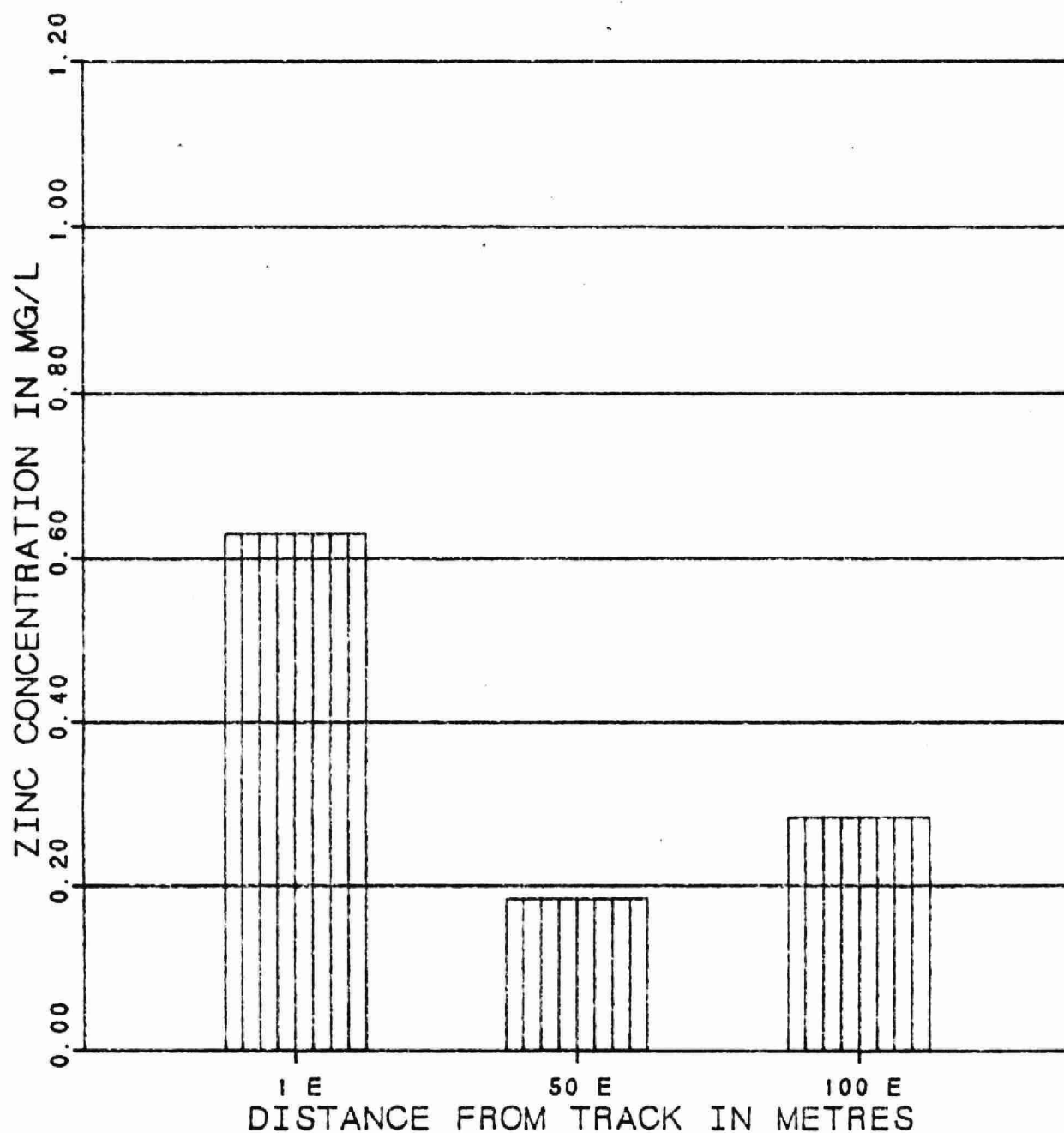


Table 1 Condition, depth and pH of snow at sampling locations
in the Timmins area - Texasgulf Study - 1983

Station	Total Depth (cm)	No. of Crust Layers	Banding in Profile	pH of Snow Melt
4	62	2	None	5.1
13	57	3	None	4.9
26	52	3	None	4.9
44	58	4	None	4.9
53	61	4	3 (faint)	5.4

Table 2 Mean concentrations of various elements in snow samples collected in the Timmins area Kidd Creek Study, 1976,1983

Station No.	Location	Year	Cd	Cu	Element Pb	Zn	Na	Cl	SO ₄
4	8kmNE	1983	.001	.02	.01	.34	3.8	5.9	1.2
13	1kmNE	1983	.006	.36	.05	.95	2.1	1.9	1.8
26	1.6kmENE	1983	.003	.12	.03	.61	1.2	1.9	2.4
26	1.6kmENE	1976	-	.07	.04	.97	1.6	2.8	.4
44	.8kmNE	1983	.009	.56	.08	1.35	.2	.3	2.7
44	.8kmNE	1976	.020*	.04*	.08*	2.95*	.3*	.5*	2.3*
53	.1kmS	1983	.007	.56	.10	15.0	.4	.4	19.8
53	.1kmS	1976	.23	1.9	.65	106	.9	2.7	19.0

* Reported values are of March samples whereas all other values are of February collections.

Table 3 Condition depth and pH of snow at sampling locations in the Timmins Railroad Study, 1983

Station	Total Depth (cm)	No. of Crust Layers	Banding in Profile	pH of Snow Melt
38 (1m North)	65	4	0	4.7
38 (50m North)	49	4	0	4.9
38 (100m North)	63	4	0	4.9
38 (1m South)	60	3	0	4.9
38 (50m South)	27	3	0	4.7
38 (100m South)	53	4	0	5.1
39 (1m North)	51	3	0	4.7
39 (50m North)	56	3	0	4.5
39 (100m North)	55	3	0	5.0
39 (1m South)	64	3	0	5.3
39 (50m South)	43	4	0	5.4*
39 (100m South)	58	3	0	4.8
41 (1m East)	89	4	0	5.1
41 (50m East)	69	3	0	4.5
41 (100m East)	60	3	0	4.6

* value represents single sample, all other values are the mean of duplicate samples.

Table 4 Mean concentrations of various elements in snow samples collected at Site 38, Timmins Railroad Study, 1975 and 1983.

Station No.	Location	Year	Cd	Cu	Element Pb	Zn	Na	Cl	SO ₄
38	1m N	1983	.0605	.415	.119	1.65	.37	.64	1.97
38	50m N	1983	.0050	.240	.036	1.10	.40	.45	1.80
38	100m N	1983	.0025	.235	.033	1.51	.30	.49	2.08
38	1m S	1983	.0060	.505	.049	1.25	1.23	2.63	2.46
38	1m S	1975	.04	.37	.15	5.75	1.51	2.6	2.5
38	50m S	1983	.0030	.25	.038	.86	1.28	2.0	2.04
38	50m S	1975	.02	.25	.10	5.0	3.0*	6.0*	-
38	100m S	1983	.0025	.225	.042	.63	10.04	16.00	2.61
38	100m S	1975	.03	1.9	.09	4.8	11.25	18.50	3.3

* March values, all others are of February collection.

Table 5 Mean concentrations of various elements in snow samples collected at Site 39, Timmins Railroad Study, 1975 and 1983.

Station No.	Location	Year	Element						
			Cd	Cu	Pb	Zn	Na	Cl	SO ₄
39	1m N	1983	.0015	.13	.02	.435	.92	1.33	1.60
39	50m N	1983	.002	.16	.023	.53	1.28	.84	2.01
39	100m N	1983	.0025	.13	.023	.53	.57	.60	1.46
39	1m S	1983	.0020	.10	.028	.625	6.6	10.38	1.75
39	1m S	1976	.02	1.75	.36	3.5	8.3	12.25	1.9
39	50m S	1983	.0030	.32	.055	.66	22.4	34.3	2.94
39	100m S	1983	.0015	.12	.021	.44	2.75	3.80	1.43

Table 6 Mean concentrations of various elements in snow samples collected at Site 41, Timmins Railroad Study, 1975 and 1983.

Station No.	Location	Year	Element (mg/L)					Cl	SO ₄
			Cd	Cu	Pb	Zn	Na		
41	1m E	1983	.0035	.10	.04	.63	.7	1.02	1.37
41	1m E	1975	.03	1.1	.44	4.3	.11	.23	.9
41	50m E	1983	.0005	.03	.09	.18	.57	.23	1.08
41	50m E	1975	.01	.33	.13	1.4	.06	.18	.8
41	100m E	1983	.0005	.03	.01	.28	.15	.25	.94
41	100m E	1975	-	.12	.06	.59	.12	.28	.7

* March values, all other values are of February collection.

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